BIOLOGICAL EVALUATION OF GYPSY MOTH

AT

CHESAPEAKE MARSHLANDS NATIONAL WILDLIFE REFUGE COMPLEX

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February 2003

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ABSTRACT

From November of 2002 through January of 2003, USDI Fish and Wildlife Service personnel and USDA Forest Service personnel conducted a gypsy moth egg mass survey at Chesapeake Marshlands National Wildlife Refuge Complex (CMNWRC) to evaluate the efficacy of the 2002 treatment areas and to assess the potential for defoliation and the need for treatment in 2003. Current populations are sufficient to cause noticeable defoliation on 799 acres. In order to protect Delmarva fox squirrel habitat, treatment is recommended in these areas in 2003.

METHODS

The survey area consisted of all areas that were treated in 2002 and in stands that were previously identified as being fair or good fox squirrel habitat with a moderate or high potential for gypsy moth defoliation (Whiteman and Onken, 1994). The survey was also conducted in stands acquired in stands after 1994 that have a significant oak component. These new stands would have a high potential for gypsy moth defoliation and also good fox squirrel habitat. The 46 stands that were surveyed are presented in Figure 1.

Within each stand, gypsy moth survey plots were randomly selected based upon available host trees (oak species), size of sample area and uniformity between egg mass counts. At each sample point, a 1/40th acre fixed radius plot was established. The plots consisted of a tally of all the new (2002) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was multiplied by 40 to determine the number of egg masses per acre.

Egg mass length was measured at most of the plots to determine the overall "health" of the existing population and as a measure of egg mass fecundity. The average egg mass length (measured in millimeters) and egg mass density (egg masses per acre) were used to estimate defoliation potential (Liebhold et al., 1993).

RESULTS

The location of the survey plots are shown in Figures 2a-2d and the survey results are summarized in Table 1. Overall egg mass densities ranged from 0-11,280 and averaged 770 egg masses per acre. Egg mass densities are high in Stands 26, 51, 60, 62, 63, 66, 70 and 72 along with a portion of Stands 27, 29, 39 and 68. Egg mass densities in Stands 1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 21, 23, 25, 32, 33, 34, 35, 37, 41, 44, 56, 57, 58, 61, 64, 65, 67, 69, 71, 73, 74, 75, and 76 and the rest of 27, 29, 39 and 68 are not expected to cause noticeable defoliation. Egg mass length at CMNWRC tended to be moderate in size, averaging 27 mm and ranging from 14-40 mm.

Egg mass survey results for the 6 stands (643 acres) treated in 2002 are summarized in Table 2. Overall, the average egg mass density was reduced 80 percent from the pre-treatment level of 3,608 to the current level (post-treatment) of 719 egg masses per acre. Egg mass densities were reduced by at least 95 percent in four of the six stands and by 72 percent in another stand. In Stand 62, egg mass densities increased by thirteen percent. Only 7 percent (43 acres) of the 2002 treatment areas need to be re-treated in 2003. Although 147 acres of defoliation were detected at CMNWRC in 2002, only two of those acres were located within the treatment areas (Figure 3).

Figure 1.--Stands surveyed for gypsy moth egg masses at Chesapeake Marshlands NWR Complex, Nov 2002 - Jan 2003.

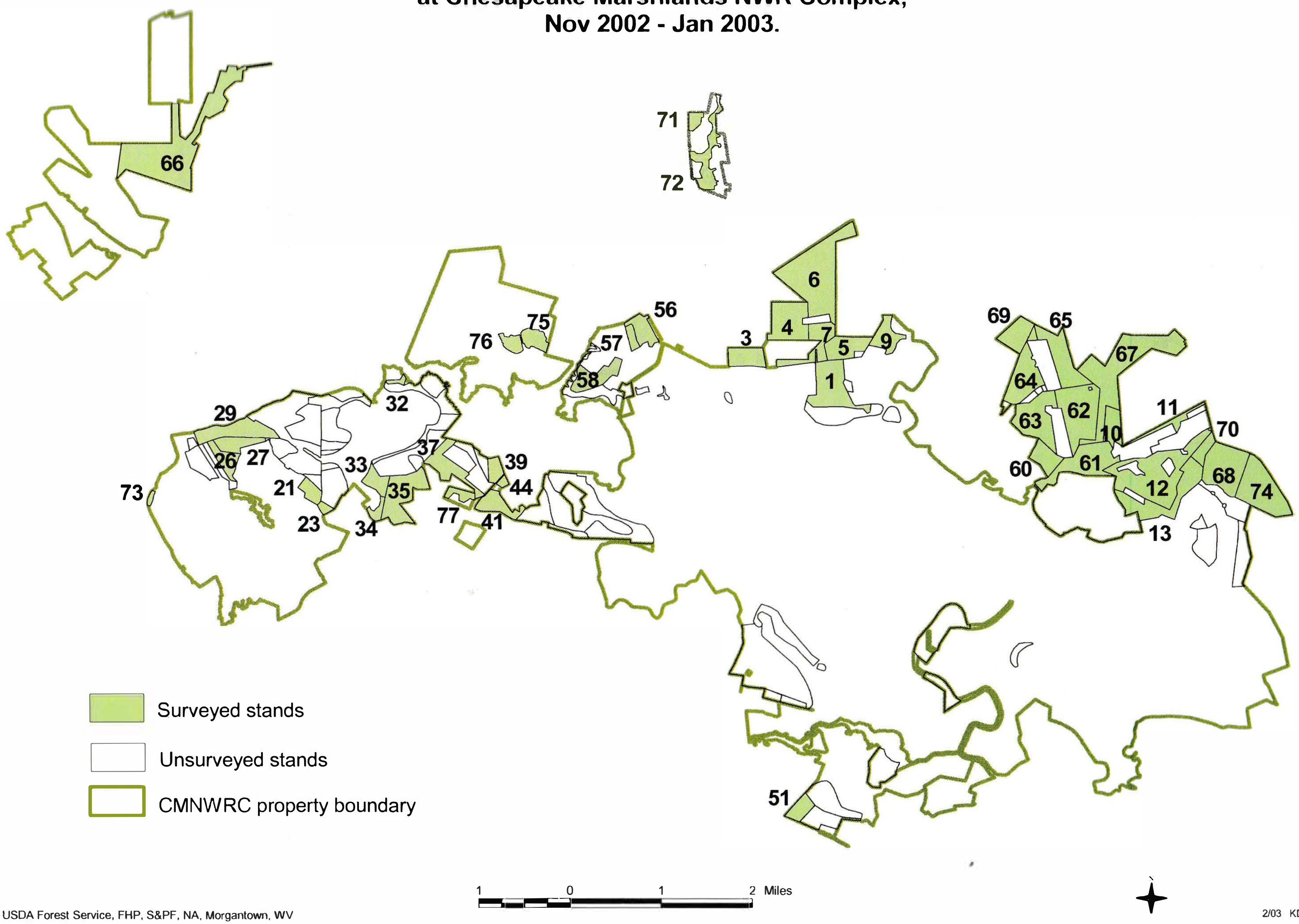

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Figure 2a.--Gypsy moth plot locations at Chesapeake Marshlands NWR Complex, Nov 2002 - Jan 2003 (Northern and Southern stands).

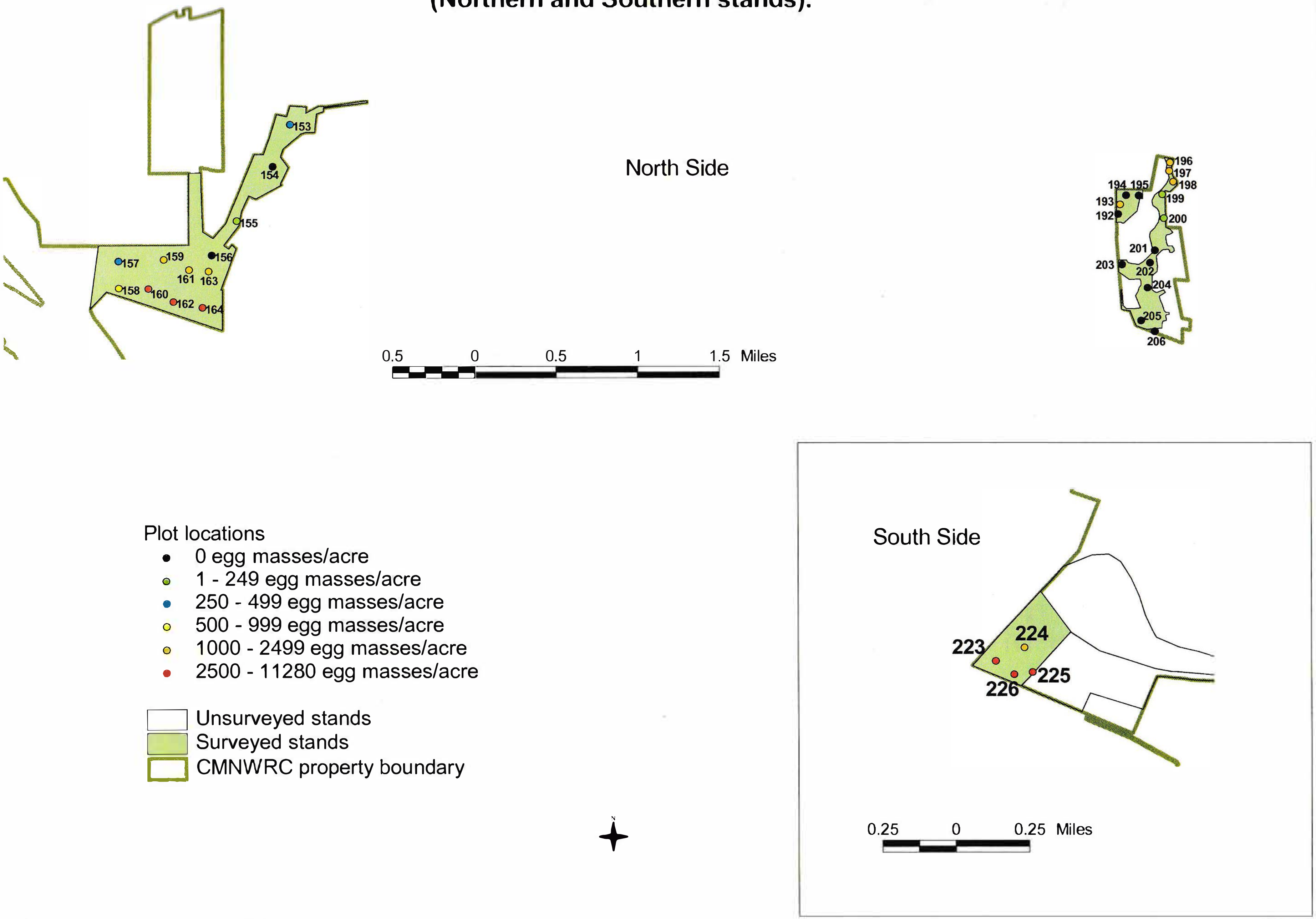

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Figure 2b.--Gypsy moth plot locations at Chesapeake Marshlands NWR Complex, Nov 2002 - Jan 2003 (West Side).

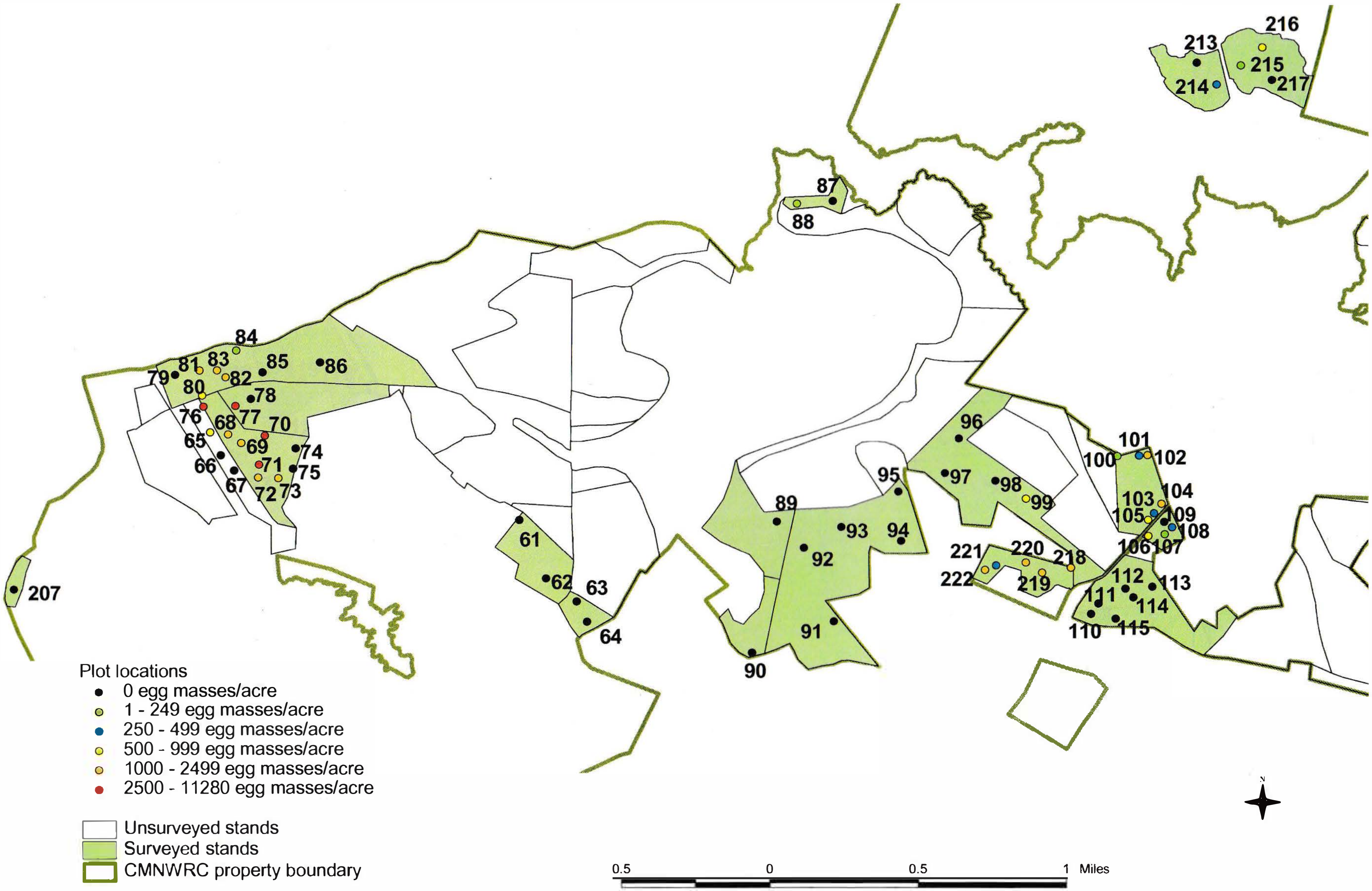

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Figure 2c.--Gypsy moth plot locations at Chesapeake Marshlands NWR Complex, Nov 2002 - Jan 2003 (Center).

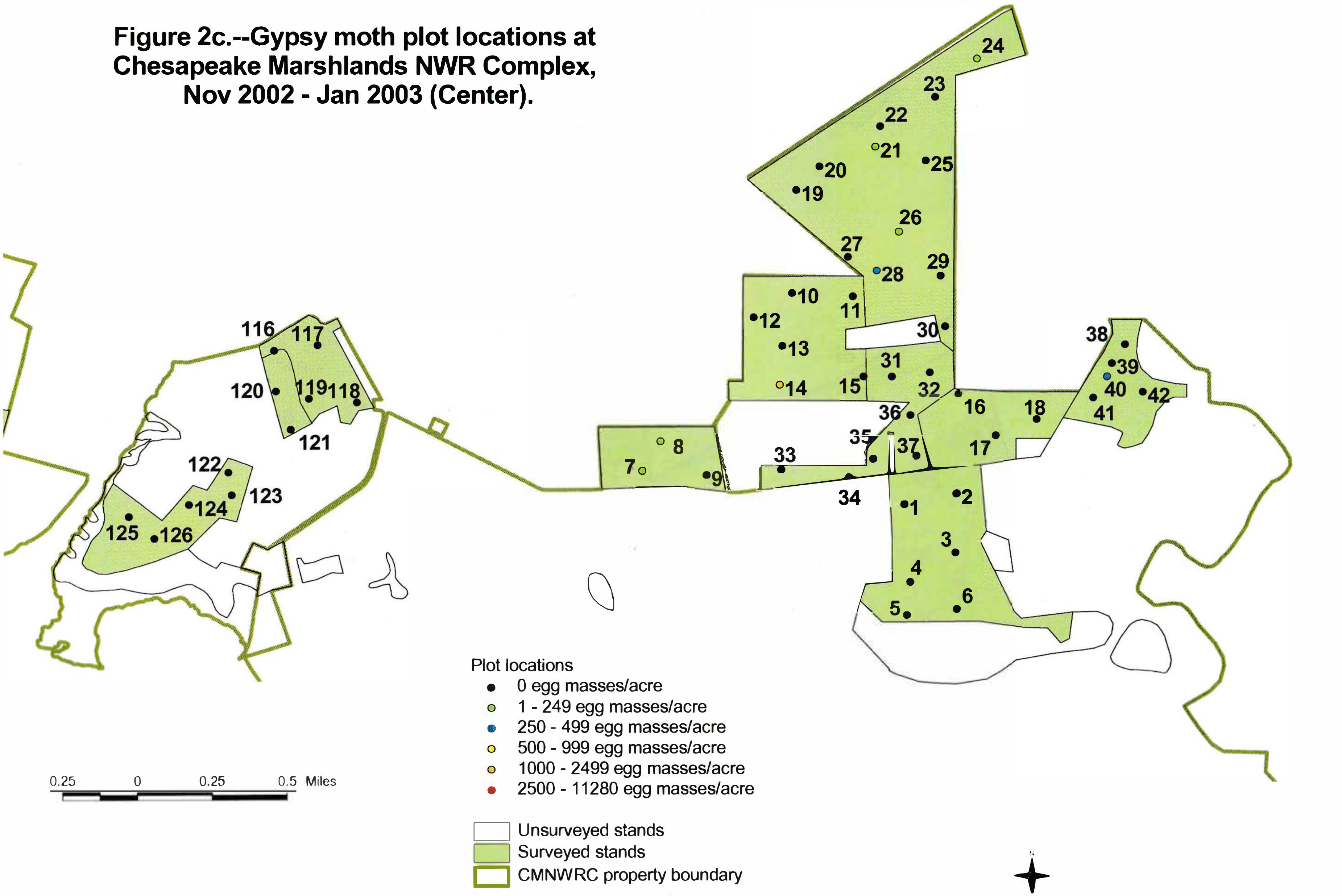

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Figure 2d.--Gypsy moth plot locations at Chesapeake Marshlands NWR Complex, Nov 2002 - Jan 2003 (East Side).

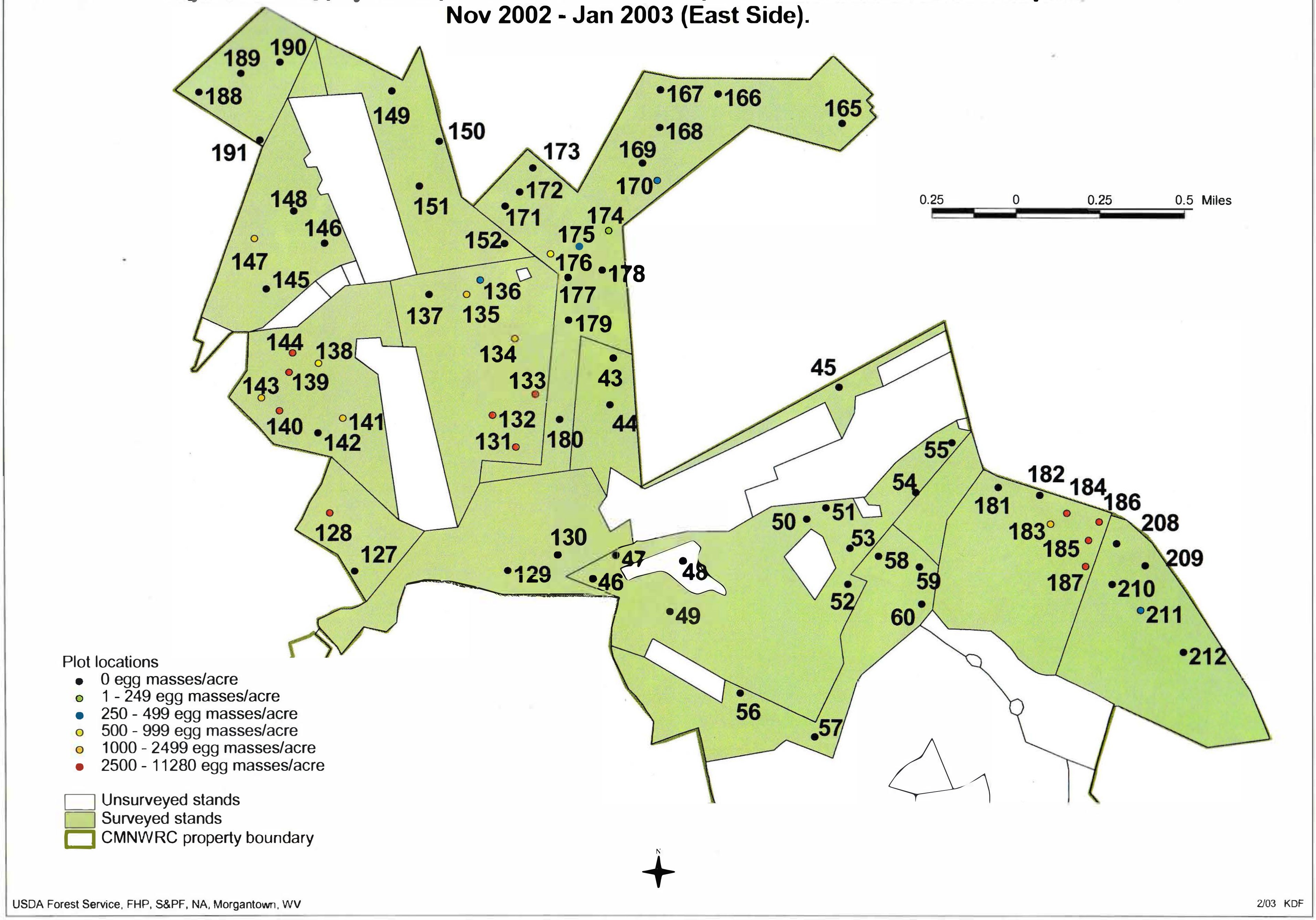
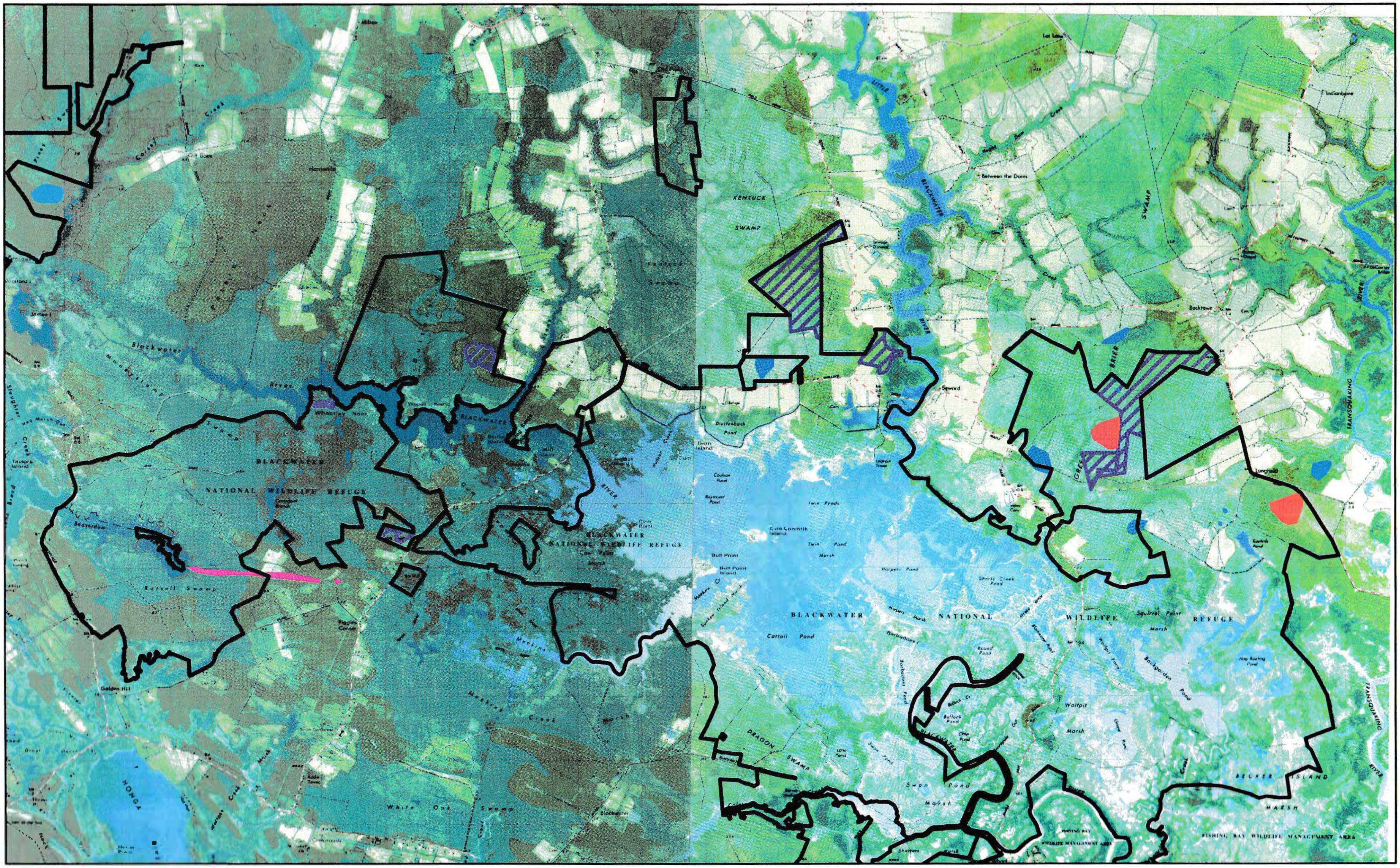


Figure 3.-- Results of the aerial detection survey conducted on June 12, 2002, along with the 2002 gypsy moth treatment areas at Chesapeake Marshlands NWR Complex.



Heavy Defoliation (61-100%)
84 acres on site
0 acres within treatment blocks

Moderate Defoliation (31-60%)
62 acres off site
63 acres on site
2 acres within treatment blocks

Tornado Damage
20 acres on site
25 acres off site

2002 Treatment Area

Chesapeake Marshland NWR Complex Boundary

DISCUSSION

All the surveyed stands are valued habitat for the Delmarva fox squirrel. Gypsy moth defoliation would have a negative impact on the value of these stands for this squirrel.

The basic guidelines used to evaluate the risk of defoliation include: previous defoliation events; number of egg masses/acre; size and condition of the egg masses; available preferred food; and risk of larval blow-in following egg hatch. Potential defoliation is categorized as; light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

The survey results indicate that heavy defoliation is likely to occur on approximately 235 acres and moderate defoliation on 564 acres at CMNWRC in 2003 (Figure 4).

This conclusion is further supported when egg density is used as a means of predicting defoliation. Moore and Jones (1987) found that estimating the mean fecundity will increase the precision of gypsy moth density estimates and that a linear relationship exists between egg mass length and fecundity. Further work by Liebhold et al., (1993) demonstrates that the product of the mean egg mass length (mm) and egg mass density provides a more precise means of estimating population densities and predicting defoliation. Using Liebhold's model, Figure 5 shows how this information can be used to correlate the predicted defoliation of Stand 26. Accordingly, the estimated egg mass density of 2,151 egg masses per acre (egg mass density in Stand 26) x 26 mm (average egg length) translates to a projected defoliation level of about 50 percent (moderate defoliation). Because egg mass densities and host type are not evenly distributed, actual defoliation will vary from tree to tree but will be predominately moderate throughout this stand. Table 3 shows the projected defoliation level in all the surveyed stands.

Egg masses longer than 25 mm typically indicate healthy populations with no obvious stress from the gypsy moth nucleopolyhedrosis virus (NPV), a primary natural control agent that often expresses itself in declining or stressed populations. It is possible that either the gypsy moth fungus or the NPV could cause the collapse of defoliating levels of gypsy moth, however, it is unlikely that populations will collapse prior to a significant defoliation event occurring in 2003.

Based on existing egg mass densities and the general size of egg masses, gypsy moth populations appear to be building and healthy in some stands, static or slightly declining in some stands and low to non-existent in other stands.

Predicting the extent of tree mortality that would occur after one year's defoliation is difficult, however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that are defoliated in excess of 60 percent normally refoliate the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate. Depending on the condition of the trees at the time of defoliation, reduced growth, mast abortion, branch dieback or in some cases tree mortality, has occurred following a single year of heavy defoliation. Should subsequent defoliation occur the following year, the impact is compounded. Trees that receive light-moderate defoliation (< 60 percent) are not likely to refoliate and there is probably no significant

Figure 4.--Areas where gypsy moth defoliation is likely/proposed treatment areas in 2003 at Chesapeake Marshlands NWR Complex.

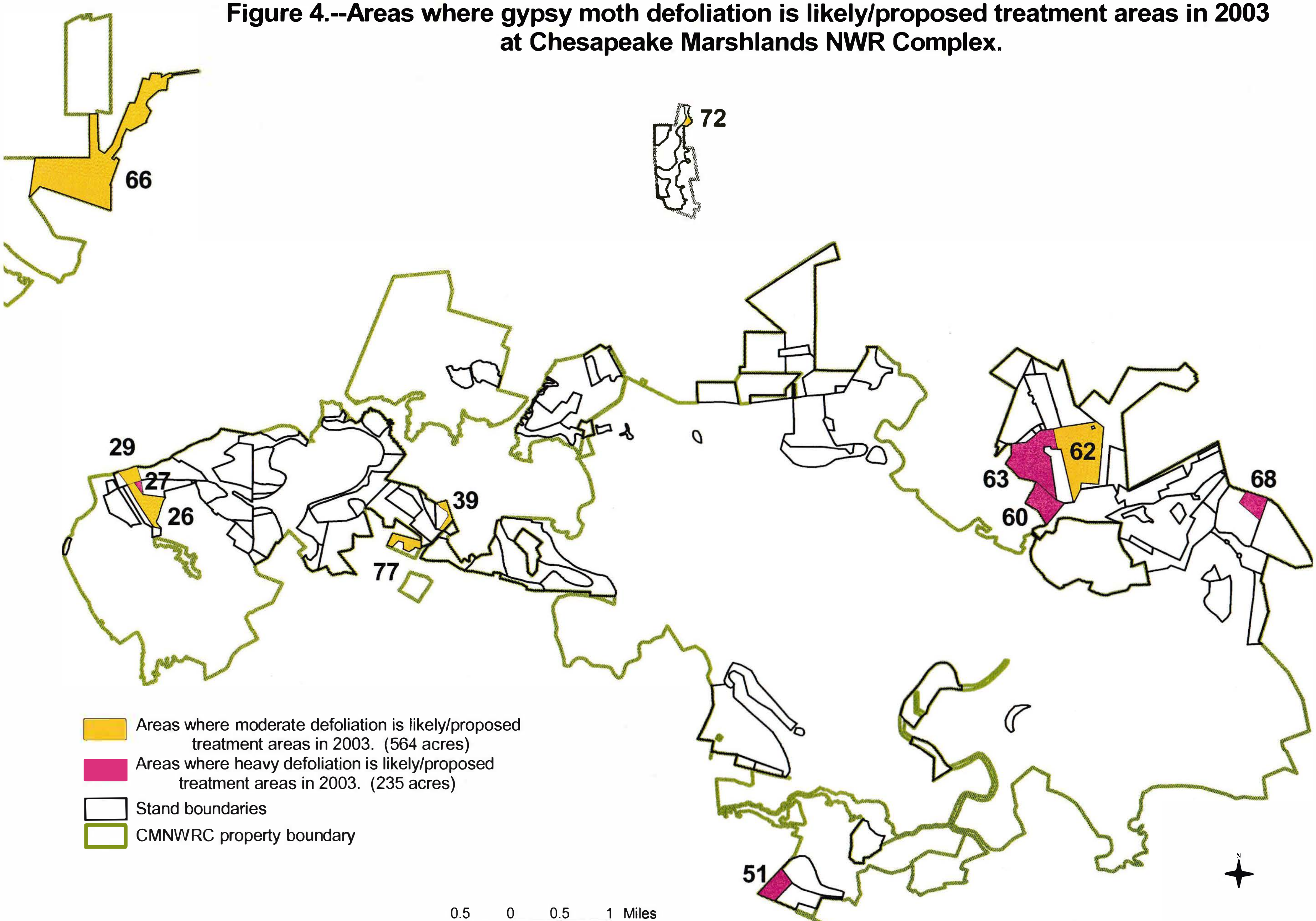


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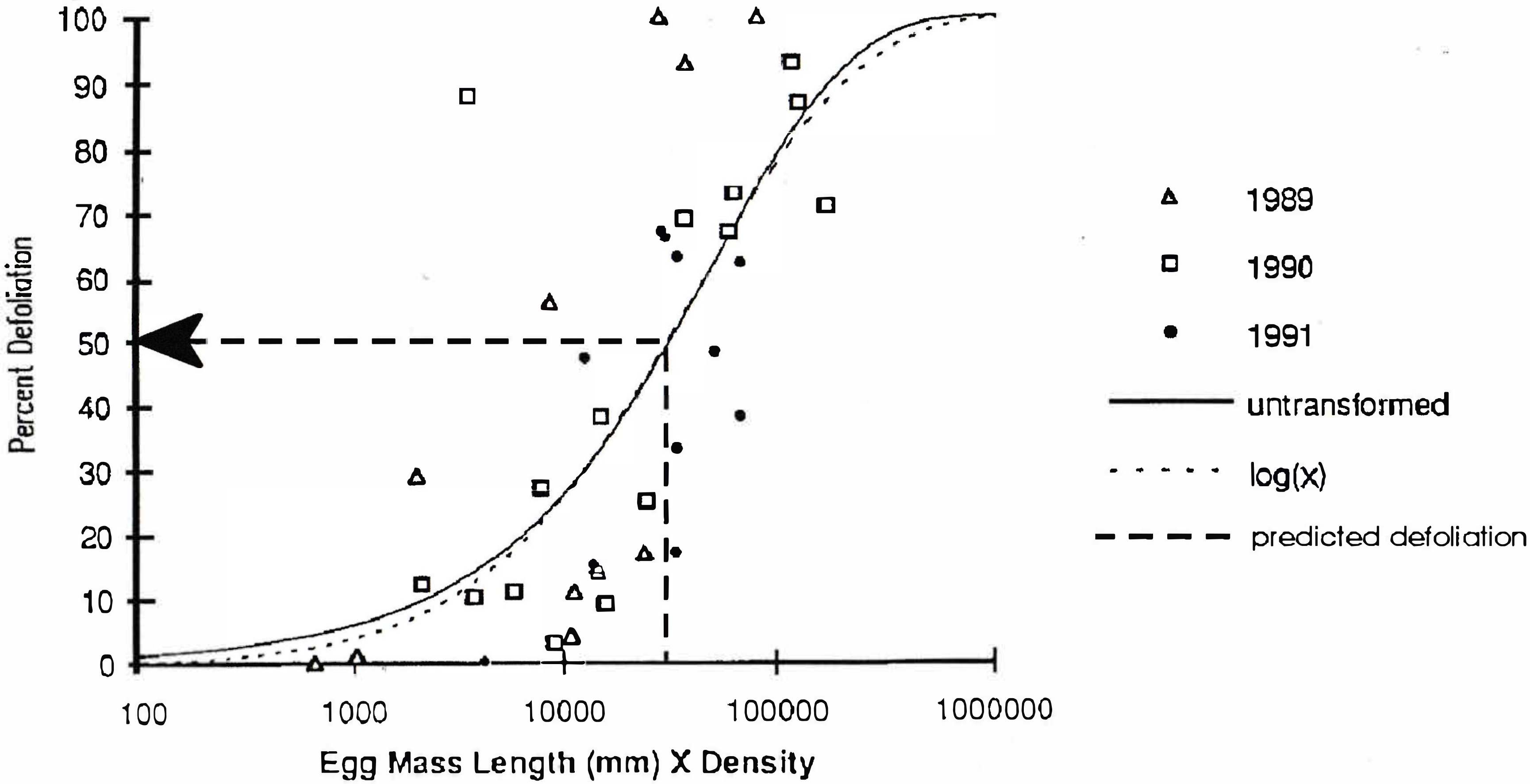
Figure 5.--Predicted defoliation in stand 26 in 2003.



Scatter plot of the product of mean egg mass length and egg mass density versus mean defoliation. Extracted from Liebhold et al. (1993).

impact other than a reduction in growth, reduction of mast and possibly some minor branch dieback.

Trees at greater risk are those that are presently stressed from other factors, such as soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; over maturity; drought; shock due to recent timber cutting activities; previous year(s) defoliation; and other insect and disease related problems. A severe drought was experienced in this portion of Maryland during the summer months in 2002. Nineteen acres of defoliation was detected at CMNWRC in 2001 while 147 acres were detected in 2002.

The Allegheny National Forest (1988), the West Virginia Division of Forestry (1997) and the Cuyahoga Valley National Park (2002) provide examples of potential tree mortality. On the Allegheny National Forest, untreated stands consisting of 40-80 percent oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28) percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. In a 1986 study area in eastern West Virginia where oak species accounted for 63-78 percent of the species composition, a loss of 25 percent of the total oak sawtimber and 14 percent of the total oak poletimber occurred after one year of moderate to heavy defoliation. At Cuyahoga Valley Park, following one year of heavy defoliation, significant mortality occurred in approximately 25 percent of the defoliated areas. In the mortality areas, oak mortality ranged from 22-98 percent and averaged 54 percent. In these examples, droughty conditions likely contributed to the level of mortality. Similar levels of mortality are likely at CMNWRC if heavy defoliation occurs in addition to a dry growing season in 2003.

Gypsy moth defoliation also has a significant impact on mast production. The potential loss of acorn mast was demonstrated by McConnell in 1988 (Gottschalk, 1990). His study found that moderate defoliation reduced production by about 50 percent and heavy defoliation near 100 percent. Other studies conducted by the Pennsylvania Game Commission had similar results and found that reduced acorn production continued for 1-2 years following the last year of defoliation.

Management Options

For 2003, two management options have been evaluated for managing gypsy moth populations at CMNWRC. The intervention options are offered based upon the following two treatment objectives: 1) protect host tree foliage to prevent mast failure and tree mortality; and 2) reduce gypsy moth populations below treatment thresholds. Each is discussed below.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of nucleopolyhedrosis virus (NPV) or the more recently recognized fungal pathogen, *Entomophaga maimaiga.* In areas with defoliating level gypsy moth populations (greater than 750 egg masses per acre) viral epizootics generally manifest themselves after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels. Although it is not possible to accurately assess such events with the

information at hand, it is unlikely that a collapse will occur prior defoliation since most of the areas are newly infested and there is an abundance of large healthy egg masses.

Large numbers of gypsy moth caterpillars and defoliation has been shown to impact competing native herbivore arthropods. Sample et al. (1996) showed short-term impacts of both species richness and abundance occurred following light to moderate defoliation events in study plots in West Virginia. It is likely that impacts would be greater as the size of the area and intensity of defoliation increases and be more long term, should extensive tree mortality occur.

Should this option be selected, it is likely that moderate and heavy defoliation will occur on 799 acres. Gypsy moths may also spread and infest other stands that are currently uninfested.

Microbial Insecticide Option

***Btk*:** The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringienis* variety *kurstaki (Btk).* This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *Btk* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation. *Btk* is persistent on foliage for about 7-10 days.

Btk has been shown to impact other non-target caterpillars that are actively feeding at the time of treatment. An example of the potential impacts is provided by a study conducted by Miller (1990) in Oregon and Samples, et al. (1996) in West Virginia. Miller's study involved a large-scale (5,000 acres) eradication program where three consecutive applications of *Btk* were applied within a single season. On Garry oak, Miller found that species richness was significantly reduced in treated areas during all 3 years of the study while the total number of immature native Lepidoptera rebounded after the second year. In the Sample study, the areas treated with *Btk* were 50 acre plots and only a single treatment applied. Here too, both species richness and the total numbers of native macro-lepidopterous caterpillars and adults were reduced but only for less than 1-year. The difference in duration of the impacts between these studies is probably the result of the number of treatment applications applied and the size of the treatment area involved.

Btk formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-36 billion international units (BIUs) per acre in a single or double application. *Btk* can be applied either undiluted or mixed with water for a total volume of ½-1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater degree of population reduction are likely.

Because *Btk* is a biological insecticide, the degree of population reduction varies and may depend on, at least in part, the selected application rate, relative health of the population (building vs. declining), population densities, weather (rain and temperature), the feeding activity of the larvae following treatment, and the actual potency of the product.

Gypchek: A second microbial insecticide that is registered and available in limited quantities is the formulated nucleopolyhedrosis virus called Gypchek. This product is not available commercially but is produced in limited quantities by a cooperative effort of the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS). The active ingredient in Gypchek formulations has a very narrow host range (lymnatriids) and occurs naturally in gypsy moth populations. Normally the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. The application of Gypchek to gypsy moth populations simply expedites this process by increasing the exposure of the virus at an earlier stage. Healthy, feeding gypsy moth caterpillars become infected by ingesting contaminated foliage and soon stop feeding and die.

The efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable in the past, but recent changes in the carrier formulation have improved results significantly. The short period of viral activity on foliage (3-5 days) as well as other biological factors such as feeding activity and weather conditions can make it difficult to project treatment efficacy. Most often foliage protection can be achieved but sufficient reductions in gypsy moth densities do not always occur. Should inadequate population reduction occur, areas would need to be treated again the following year.

The normal application rate of Gypchek is 2×10^{11} occlusion bodies (OB's) per acre applied in two applications, or a single application at 4×10^{11} OB's. Due to the limited supply, priority is first given to state and federal cooperators that need to deal with federally listed threatened and endangered species associated with gypsy moth treatments. However, sufficient quantities of Gypchek are available for use at CMNWRC in 2003 should this option be selected.

Alternatives

With the previously described options in mind, the following alternatives are offered.

Alternative 1. -No action

Alternative 2. -One aerial application of *Btk* at the rate of 36 BIUs in a total mix of ¾ gallon per acre.

Alternative 3 -Two aerial applications of *Btk*, as in alternative 2, applied 4-7 days apart.

Alternative 4 -One aerial application of Gypchek at the rate of 4×10^{11} OB's in a total mix of 1 gallon per acre

Alternative 5 -Two aerial applications of Gypchek at the rate of 2×10^{11} OB's in a total mix of 1 gallon per acre, applied 3-5 days apart.

RECOMMENDATIONS

As previously stated, gypsy moth populations are sufficient to cause moderate defoliation on 564 acres and heavy defoliation on 235 acres at CMNWRC in 2003 (Figure 4). To protect host tree foliage and prevent mast failure and tree mortality, our recommendation is Alternative 4 (a single application of Gypchek). This recommendation is based on the following conditions:

1. The use of Gypchek minimizes the risk to other non-target organisms including lepidopteran caterpillars.

2. A single application of Gypchek will likely provide adequate foliage protection and reduce the existing population below the treatment threshold throughout most of the treatment area.

3. The cost of a single application of Gypchek is about one half that of a double application of Gypchek.

Only small and scattered areas of defoliation, if any, are expected elsewhere at CMNWRC in 2003.

REFERENCES

Allegheny National Forest, Warren, PA. 1988. Gypsy moth caused oak mortality – Allegheny National Forest, 1988. USDA Forest Service internal report prepared by Forest Pest Management staff, Morgantown, WV. Unp.

Cuyahoga Valley National Park, Brecksville, OH. 2002. Oak Mortality Evaluation. Cuyahoga Valley National Park, 2001. USDA Forest Service Internal report prepared by Forest Health Protection staff, Morgantown, WV. Unp.

Gottschalk, K.W. 1990. Gypsy moth impacts on mast production, *In:* McGee, Charles E. Ed. Proceedings of the Workshop, southern Appalachian Mast Management; 1989 August 14-16; Knoxville TN; University of Tennessee; 42-50.

Liebhold, A.M., Simons, E.E., Sior, A., and Unger, J.D. 1993. Forecasting defoliation caused by the gypsy moth from field measurements. Environ. Entomol. 22(1): 26-32.

Miller, J.C. 1990. Field assessment of the effects of a microbial pest control agent on non-target Lepidoptera. American Entomologist 36:2, 135-139.

Moore, K.E.B. and Jones, C.G. 1987. Field estimation of fecundity of gypsy moth (Lepidoptera:Lymnatriidae). Environ. Entomol. 16: 165-167

Sample, B.E., Butler, L., Zivkovich, C., Whitmore, R.C., and Reardon, R.C. 1996. Effects of *Bacillus thuringiensis* Berliner var. *Kurstaki* and defoliation by gypsy moth [*Lymantria dispar* (L.) (Lepidoptera:Lymnatriidae)] on native arthropods in West Virginia. The Canadian Entomologist 128:573-592.

West Virginia Division of Forestry. 1997. *In* 1997 Cooperative State-County-Landowner Gypsy Moth Suppression Program in West Virginia. 3p. (Brochure).

Whiteman, R.L., and Onken, B.P. 1994. Protecting Delmarva Fox Squirrel Habitat from Gypsy Moth and southern Pine Beetle, Blackwater National Wildlife Refuge, 1994, Unpublished Report, 46 pp.

Table 1 – Gypsy moth egg mass survey results at Chesapeake Marshlands NWR Complex, Fall 2002.

Stand 1

Plot Number	Number Em/acre	Plot Number	Number Em/acre
1	0	4	0
2	0	5	0
3	0	6	0

em/acre average = 0

Stand 3

Plot Number	Number Em/acre	Plot Number	Number Em/acre
7	160	9	0
8	160		

em/acre range = 0-160
em/acre average = 107

Stand 4

Plot Number	Number Em/acre	Plot Number	Number Em/acre
10	0	13	0
11	0	14	2,400
12	0	15	0

em/acre range = 0-2,400
em/acre average = 400

Stand 5

Plot Number	Number Em/acre	Plot Number	Number Em/acre
16	0	18	0
17	0		

em/acre average = 0

Stand 6

Plot Number	Number Em/acre	Plot Number	Number Em/acre
19	0	25	0
20	0	26	40
21	160	27	0
22	0	28	360
23	0	29	0
24	120	30	0

em/acre range = 0-360
em/acre average = 57

Stand 7

Plot Number	Number Em/acre	Plot Number	Number Em/acre
31	0	35	0
32	0	36	0
33	0	37	0
34	0		

em/acre average = 0

Stand 9

Plot Number	Number Em/acre	Plot Number	Number Em/acre
38	0	41	0
39	0	42	0
40	280		

em/acre range = 0-280
em/acre average = 56

Stand 10

Plot Number	Number Em/acre	Plot Number	Number Em/acre
43	0	44	0

em/acre average = 0

Stand 11

Plot Number	Number Em/acre
45	0

em/acre average = 0

Stand 12

Plot Number	Number Em/acre	Plot Number	Number Em/acre
46	0	51	0
47	0	52	0
48	0	53	0
49	0	54	0
50	0	55	0

em/acre average = 0

Stand 13

Plot Number	Number Em/acre	Plot Number	Number Em/acre
56	0	59	0
57	0	60	0
58	0		

em/acre average = 0

Stand 21

Plot Number	Number Em/acre	Plot Number	Number Em/acre
61	0	62	0

em/acre average = 0

Stand 23

Plot Number	Number Em/acre	Plot Number	Number Em/acre
63	0	64	0

em/acre average = 0

Stand 25

Plot Number	Number Em/acre	Plot Number	Number Em/acre
65	840	67	0
66	0		0

em/acre range = 0-840
em/acre average = 280

Stand 26

Plot Number	Number Em/acre	Plot Number	Number Em/acre
68	1,920	73	1,120
69	1,640	74	0
70	3,920	75	0
71	7,000	76	2,760
72	1,000		

em/acre range = 0-7,000
em/acre average = 2,151

em size range (mm) = 20-30
em size average (mm) = 26

Stand 27

Plot Number	Number Em/acre	Plot Number	Number Em/acre
77	3,520	78	0

em/acre range = 0-3,520
em/acre average = 1,760

em size range (mm) = 22-28
em size average (mm) = 25

Stand 29

Plot Number	Number Em/acre	Plot Number	Number Em/acre
79	0	83	1,200
80	960	84	200
81	1,120	85	0
82	2,480	86	0

em/acre range = 0-2,480
em/acre average = 745

em size range (mm) = 24-34
em size average (mm) = 29

Stand 32

Plot Number	Number Em/acre	Plot Number	Number Em/acre
87	0	88	120

em/acre range = 0-120
em/acre average = 60

Stand 33

Plot Number	Number Em/acre
89	0

em/acre average = 0

Stand 34

Plot Number	Number Em/acre
90	0

em/acre average = 0

Stand 35

Plot Number	Number Em/acre	Plot Number	Number Em/acre
91	0	94	0
92	0	95	0
93	0		

em/acre average = 0

Stand 37

Plot Number	Number Em/acre	Plot Number	Number Em/acre
96	0	98	0
97	0	99	720

em/acre range = 0-720
em/acre average = 180

Stand 39

Plot Number	Number Em/acre	Plot Number	Number Em/acre
100	240	103	320
101	400	104	1,280
102	1,480	105	600

em/acre range = 240-1,480
em/acre average = 720

em size range (mm) = 26-40
em size average (mm) = 33

Stand 41

Plot Number	Number Em/acre	Plot Number	Number Em/acre
106	0	109	0
107	0	110	0
108	0	111	0

em/acre average = 0

Stand 44

Plot Number	Number Em/acre	Plot Number	Number Em/acre
112	0	114	280
113	160	115	0

em/acre = 0-280
em/acre average = 110

Stand 56

Plot Number	Number Em/acre	Plot Number	Number Em/acre
116	0	118	0
117	0	119	0

em/acre average = 0

Stand 57

Plot Number	Number Em/acre	Plot Number	Number Em/acre
120	0	121	0

em/acre average = 0

Stand 58

Plot Number	Number Em/acre	Plot Number	Number Em/acre
122	0	125	0
123	0	126	0
124	0		

em/acre average = 0

Stand 60

Plot Number	Number Em/acre	Plot Number	Number Em/acre
127	0	128	11,280

em/acre range = 0-11,280
em/acre average = 5,640

em size range (mm) = 24-28
em size average (mm) = 26

Stand 61

Plot Number	Number Em/acre	Plot Number	Number Em/acre
129	0	130	0

em/acre average = 0

Stand 62

Plot Number	Number Em/acre	Plot Number	Number Em/acre
131	2,560	135	1,120
132	4,880	136	480
133	7,200	137	0
134	1,600		

em/acre range = 0-7,200
em/acre average = 2,549

em size range (mm) = 22-28
em size average (mm) = 26

Stand 63

Plot Number	Number Em/acre	Plot Number	Number Em/acre
138	880	142	0
139	7,400	143	2,480
140	6,560	144	4,480
141	1,600		

em/acre range = 0-7,400
em/acre average = 3,343

em size range (mm) = 20-28
em size average (mm) = 24

Stand 64

Plot Number	Number Em/acre	Plot Number	Number Em/acre
145	0	147	1,040
146	0	148	0

em/acre range = 0-1,040
em/acre average =260

Stand 65

Plot Number	Number Em/acre	Plot Number	Number Em/acre
149	0	151	0
150	0		

em/acre average = 0

Stand 66

Plot Number	Number Em/acre	Plot Number	Number Em/acre
152	0	159	2,160
153	320	160	4,800
154	0	161	2,440
155	240	162	8,360
156	0	163	1,960
157	360	164	4,480
158	800		

em/acre range = 0-8,360
em/acre average = 1,994

em size range (mm) = 26-36
em size average (mm) = 30

Stand 67

Plot Number	Number Em/acre	Plot Number	Number Em/acre
165	0	173	0
166	0	174	0
167	0	175	480
168	0	176	720
169	0	177	0
170	280	178	0
171	0	179	0
172	0	180	0

em/acre range = 0-720
em/acre average = 93

Stand 68

Plot Number	Number Em/acre	Plot Number	Number Em/acre
181	0	185	8,160
182	0	186	6,400
183	2,160	187	4,560
184	4,280		

em/acre range = 0-8,160
em/acre average = 3,651

em size range (mm) = 14-24
em size average (mm) = 20

Stand 69

Plot Number	Number Em/acre	Plot Number	Number Em/acre
188	0	190	0
189	0	191	0

em/acre average = 0

Stand 71

Plot Number	Number Em/acre	Plot Number	Number Em/acre
192	0	194	0
193	1,600	195	0

em/acre range = 0-1,600
em/acre average = 400

Stand 72

Plot Number	Number Em/acre	Plot Number	Number Em/acre
196	1,400	202	0
197	1,160	203	0
198	1,920	204	0
199	40	205	0
200	120	206	0
201	0		

em/acre range = 0-1,920
em/acre average = 422

em size range (mm) = 20-38
em size average (mm) = 31

Stand 73

Plot Number	Number Em/acre
207	0

em/acre average = 0

Stand 74

Plot Number	Number Em/acre	Plot Number	Number Em/acre
207	0	210	0
208	0	211	400
209	0	212	0

em/acre range = 0-400
em/acre average = 80

Stand 75

Plot Number	Number Em/acre	Plot Number	Number Em/acre
213	240	215	0
214	0		

em/acre range = 0-760
em/acre average = 333

Stand 76

Plot Number	Number Em/acre	Plot Number	Number Em/acre
216	0	217	360

em/acre range = 0-360
em/acre average = 180

Stand 77

Plot Number	Number Em/acre	Plot Number	Number Em/acre
218	1,040	221	440
219	1,000	222	1,360
220	1,160		

em/acre range = 440-1,360
em/acre average = 1,000

em size range (mm) = 22-30
em size average (mm) = 26

Stand 51

Plot Number	Number Em/acre	Plot Number	Number Em/acre
223	3,520	225	3,080
224	1,680	226	7,200

em/acre range = 1,680-7,200
em/acre average = 3,870

em size range (mm) = 18-25
em size average (mm) = 23

Table 2 – Comparison of pre-treatment and post-treatment egg mass densities at Chesapeake Marshlands NWR Complex.

Stand Number	Average Em/acre 2001 (pre-treatment)	Average Em/acre 2002 (post-treatment)	Percent Change
6	6,105	57	- 99
9	4,429	56	- 99
32	1,107	60	- 95
67	5,518	93	- 98
75	1,207	333	- 72
62*	3,280	3,720	+13
All Treated Stands	3,608	719	-80

* Only the southern portion of the stand was treated. Numbers reflect only the portion that was treated.

Table 3 – Projected defoliation levels for each surveyed stand at Chesapeake Marshlands NWR Complex in 2002.

Projected Defoliation		
Stand Number	Percent Defoliation	Defoliation Class
26	50%	moderate
51	70%	heavy
60	81%	heavy
62	54%	moderate
63	65%	heavy
66	53%	moderate
77	33%	moderate
27*W	70%	heavy
29*W	41%	moderate
39*S+E	32%	moderate
68*NE	78%	heavy
72*N	43%	moderate
3	7%	low
4	26%	low
6	6%	low
9	6%	low
25	18%	low
32	5%	low
44	8%	low
64	18%	low
67	7%	low
71	26%	low
74	6%	low
75	23%	low
76	10%	low
29**	5%	low
72**	2%	low

No defoliation is expected in stands 1, 5, 7, 10, 11, 12, 13, 21, 23, 33, 34, 35, 41, 56, 57, 58, 61, 65, 69, 73 and the rest of stands 27, 39 and 68.

* W = western portion of stand
* S+E = southern and eastern portions of stand
* NE = northeastern portion of stand
* N = northern portion of stand
** = rest of stand

United States Department of Agriculture | Forest Service | Northeastern Area State & Private Forestry | 180 Canfield Street Morgantown, WV 26505-3101

File Code: 3400
Date: February 19, 2003

Glenn Carowan, Refuge Manager
USDI Fish and Wildlife Service
Chesapeake Marshlands National Wildlife Refuge Complex
2145 Key Wallace Drive
Cambridge, MD 21613

Dear Mr. Carowan:

Enclosed is the gypsy moth biological evaluation for Chesapeake Marshlands National Wildlife Refuge Complex. Current gypsy moth populations are sufficient to cause noticeable defoliation on 799 acres. We are recommending a single application of Gypchek for these areas. With proper application, gypsy moth defoliation should be minimal at your site in 2003.

The 2002 gypsy moth suppression project was successful as foliage protection was provided for 99.7 percent of the treatment area, overall egg mass densities in the treatment area were reduced 80 percent and only 7 percent of this treatment area needs to be re-treated in 2003.

If you have any questions concerning this biological evaluation, please contact Rod (304-285-1555) or Brad (304-285-1546).

I would also like to thank your staff for their assistance in the egg mass survey.

Sincerely,

JOHN W. HAZEL
Field Representative
Morgantown Field Office

Enclosure

cc: Tom Eagle, Forester, CMNWRC
Allen Carter, Regional Forester, USDI F&WS
Bob Tichenor, MDA
Steve Tilley, MDA
Noel Schneeberger, AO

JWH/RLW/blm